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ABSTRACT

This experiment examined the accuracy with which newborn infants orient their heads toward a sound positioned off midline within hemifields. The study also evaluated newborns' ability to update the angle of their head turn to match a change in localization of an ongoing sound. Alert newborns were held in a supine position and presented a sound at 36, 54, 72, or 90 degrees relative to midline. On shift trials, after a head turn, the sound moved to a new loudspeaker location within the same hemifield. On no-shift trials, the sound remained at one location throughout the trial. Measurement of the incidence and angle of first and adjustment head turns indicated more adjustments on shift than no-shift trials. The magnitude of error of localization increased as the sound moved off midline. Infants tended to undershoot rather than overshoot the actual location of the sound source when making a head turn. These results suggest that newborns not only discriminate sound direction but have some capacity to localize sounds. (BC)

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NEWBORNS' HEAD ORIENTATION TOWARD SOUNDS WITHIN HEMIFIELDS

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ABSTRACT

ALERT NEWBORNS WERE HELD IN A SUPINE POSITION AND PRESENTED A SOUND AT 36, 54, 72 OR 90 DEGREES RELATIVE TO MIDLINE (0 DEGREES). ON "SHIFT TRIALS", AFTER A HEAD TURN, THE SOUND MOVED TO A NEW LOUDSPEAKER LOCATION WITHIN THE SAME HEMIFIELD. ON "NO-SHIFT" TRIALS, THE SOUND REMAINED AT ONE LOCATION THROUGHOUT THE TRIAL. MEASUREMENT OF THE INCIDENCE AND ANGLE OF FIRST AND ADJUSTMENT HEAD TURNS INDICATED MORE ADJUSTMENTS ON SHIFT THAN NO-SHIFT TRIALS AND DIFFERENTIAL HEAD TURN ANGLES AS A FUNCTION OF SOUND AZIMUTH. THE MAGNITUDE OF ERROR FOR A HEAD TURN WAS DEFINED AS THE DIFFERENCE IN DEGREES BETWEEN THE ANGLE OF AN INFANT'S HEAD TURN AND THE ACTUAL LOCATION OF THE SOUND SOURCE. ANALYSES INDICATED THAT THE MAGNITUDE OF LOCALIZATION ERROR INCREASED LINEARLY AS THE SOUND MOVED INCREASINGLY OFF MIDLINE AND THAT INFANTS TENDED TO UNDERSHOOT (i.e., FALL SHORT OF) RATHER THAN OVERSHOOT (i.e., GO BEYOND) THE ACTUAL LOCATION OF THE SOUND SOURCE WHEN MAKING A HEAD TURN. THESE RESULTS SUGGEST THAT NEWBORNS NOT ONLY DISCRIMINATE SOUND DIRECTION BUT HAVE SOME CAPACITY TO LOCALIZE SOUNDS.

RATIONALE

NEWBORNS CAN DIRECTIONALLY DISCRIMINATE OR LATERALIZE SOUNDS, AS EVIDENCED BY THE FINDING THAT NEWBORNS TURN THEIR HEADS RELIABLY IN THE DIRECTION OF A SOUND SOURCE POSITIONED EITHER TO THE LEFT OR RIGHT OF MIDLINE.

LATERALIZATION IS NECESSARY BUT NOT SUFFICIENT FOR LOCALIZATION, WHICH ENTAILS THE MORE COMPLEX ABILITY OF PINPOINTING THE SOURCE OF A SOUND IN SPACE.

NUMEROUS STUDIES INDICATE THAT ACCURACY IN SOUND LOCALIZATION IMPROVES WITH AGE BETWEEN 2 AND 18 MONTHS POSTNATALLY, BUT LITTLE IS KNOWN ABOUT ACCURACY OF SOUND LOCALIZATION IN NEWBORNS.

AIMS

(1) TO EXAMINE THE ACCURACY WITH WHICH NEWBORN INFANTS ORIENT THEIR HEADS TOWARD A SOUND POSITIONED OFF MIDLINE WITHIN HEMIFIELDS.

(2) TO EVALUATE NEWBORNS' ABILITIES TO UPDATE THE ANGLE OF THEIR HEAD TURN TO MATCH A CHANGE IN LOCALIZATION OF AN ONGOING SOUND.

METHOD

SUBJECTS:

34 FULLTERM HEALTHY NEONATES

STIMULI:

WHITE NOISE BURSTS (1 PER SECOND) PRESENTED AT NORMAL CONVERSATION LEVEL (64 dB).

APPARATUS:

CUSTOM-BUILT ARCH WITH 8 SPEAKERS POSITIONED WITHIN THE ARCH, ONE EACH AT 36, 54, 72 & 90 DEGREES ON EITHER SIDE OF MIDLINE (0 DEGREES).

PROCEDURE:

ALERT NEWBORNS WERE HELD IN A SUPINE POSITION WITHIN THE ARCH WITH THEIR HEADS CENTERED AT 0 DEGREES (SEE FIGURE 1).

A STRIP OF SURGICAL TAPE WITH A BLACK LINE DRAWN VERTICALLY DOWN THE CENTRE WAS PLACED ON THE CROWN OF THE INFANT'S HEAD IN A ROSTRAL TO CAUDAL FASHION TO AID IN SCORING HEAD TURN ANGLES (SEE FIGURE 2a).

EACH INFANT RECEIVED TWO TYPES OF TRIALS:

(1) SHIFT TRIALS: AFTER AN INITIAL HEAD TURN IN THE DIRECTION OF THE SOUND SOURCE, THE SOUND MOVED TO A SECOND LOCATION WITHIN THE SAME HEMIFIELD.

(2) NO-SHIFT TRIALS: THE SOUND REMAINED AT ONE SPEAKER THROUGHOUT THE TRIAL.

EACH INFANT RECEIVED 8 SHIFT AND 8 NO-SHIFT TRIALS. SHIFT TRIALS INCLUDED 2 TRIALS EACH ON WHICH THE SOUND SHIFTED FROM 90 TO 54 DEGREES AND VICE VERSA AND FROM 72 TO 36 DEGREES AND VICE VERSA. NO-SHIFT TRIALS INCLUDED 2 TRIALS AT EACH OF THE 4 LOUDSPEAKER LOCATIONS (36, 54, 72, 90 DEGREES), ONE ON EITHER SIDE OF MIDLINE.

Video-Coding and Data Reduction:

HEAD TURNS THAT WERE HELD FOR AT LEAST 1 SECOND WERE COUNTED AS RESPONSES AND SCORED USING A PROTRACTOR POSITIONED ON THE VIDEO-SCREEN (SEE FIGURE 2b AND c).

DIRECTION AND ANGLE WERE SCORED FOR INITIAL HEAD TURNS AND FOR ADJUSTMENTS IN HEAD TURN ANGLE WHEN THEY OCCURRED. HEAD TURN ANGLES WERE THEN CONVERTED TO "ERROR SCORES", THAT IS, THE DISCREPANCY BETWEEN THE ANGLE OF THE INFANT'S HEAD TURN AND THE ACTUAL LOCATION OF THE SOUND SOURCE IN DEGREES FROM MIDLINE (SEE FIGURE 2c). LIKE TRIALS WERE AVERAGED TO YIELD ONE ERROR SCORE FOR EACH LOCATION ON SHIFT AND NO-SHIFT TRIALS.

RESULTS

NEWBORNS EXECUTED A HEAD TURN ON 86% OF THE TRIALS. AN ADJUSTMENT IN HEAD TURN ANGLE OCCURRED ON 36% OF SHIFT TRIALS.

AS CAN BE SEEN IN TABLE 1, AT EACH ANGLE, SUBSTANTIALLY MORE UNDERSHOOTS (i.e., HEAD TURN FALLS SHORT OF ACTUAL LOCATION OF SOUND SOURCE) OCCURRED THAN OVERSHOOTS (i.e., HEAD TURN ANGLE EXCEEDS ACTUAL LOCATION OF SOUND SOURCE).

FOR FIRST HEAD TURNS, THE MAGNITUDE OF ERROR (AVERAGED ACROSS THE ABSOLUTE VALUE OF UNDERSHOOT AND OVERSHOOT RESPONSES) INCREASED LINEARLY AS THE SOUND SOURCE MOVED INCREASINGLY OFF MIDLINE (SEE FIGURE 4).

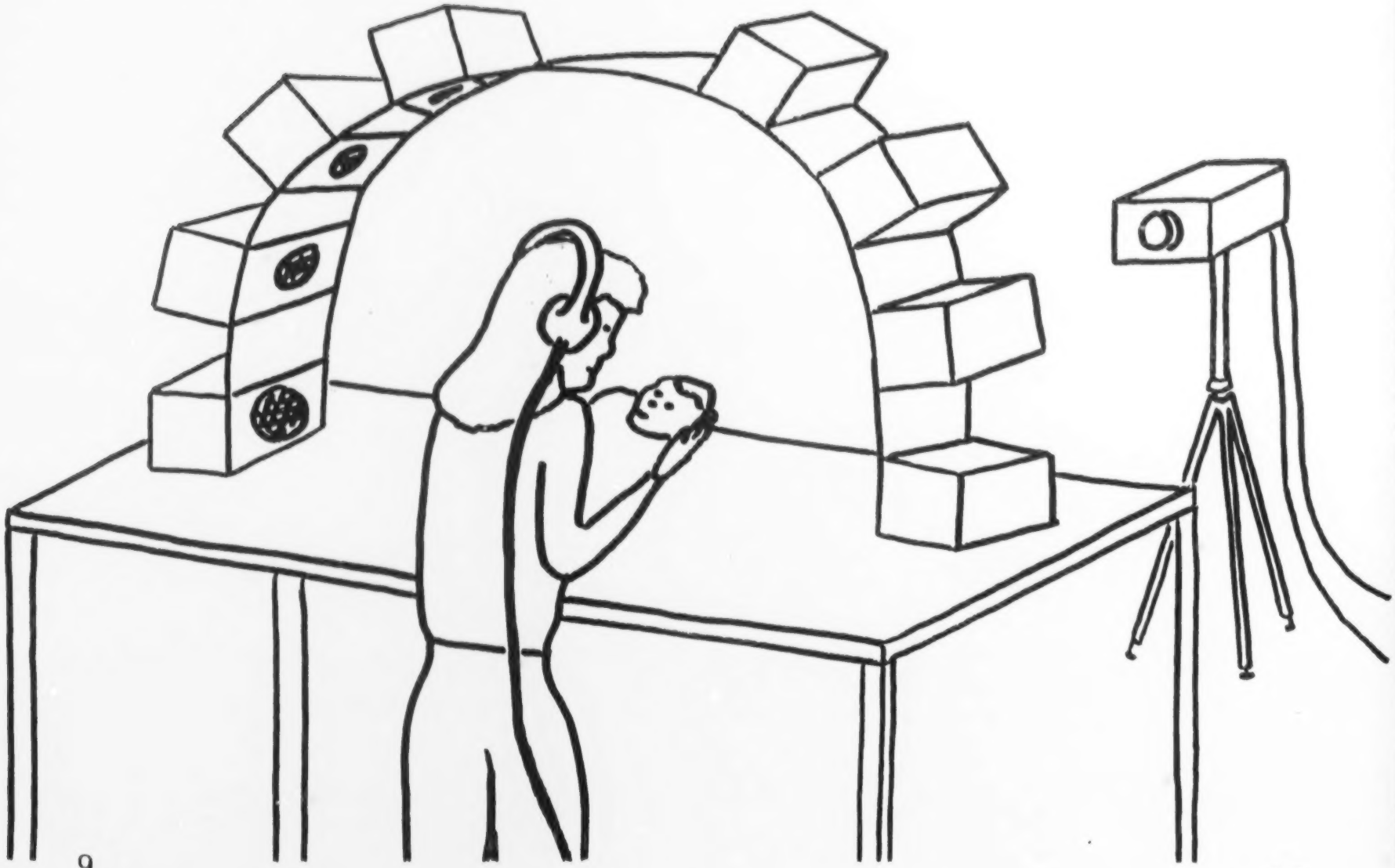
FOR ADJUSTMENT HEAD TURNS, THE MAGNITUDE OF ERROR ALSO INCREASED LINEARLY AS THE SOUND SOURCE MOVED INCREASINGLY OFF MIDLINE (SEE FIGURE 4). HOWEVER, THE MAGNITUDE OF ERROR TENDED TO BE LESS FOR ADJUSTMENT THAN FOR FIRST HEAD TURNS.

CONCLUSIONS

(1) NEWBORNS HEAD TURNED RELIABLY IN THE DIRECTION OF A SOUND SOURCE REPLICATING PREVIOUS FINDINGS THAT NEWBORNS LATERALIZE SOUNDS.

(2) NEWBORNS HAVE SOME CAPACITY TO LOCALIZE OR PINPOINT A SOUND'S LOCATION IN SPACE AS EVIDENCED BY THE FINDING THAT HEAD TURN ANGLES INCREASED LINEARLY AS THE SOUND MOVED INCREASINGLY OFF MIDLINE.

(3) NEWBORNS SHOWED SOME ABILITY TO ATTEND TO A CHANGE IN THE LOCATION OF AN ONGOING SOUND AND TO RESPOND TO THAT CHANGE BY UPDATING THEIR HEAD TURN ANGLE.



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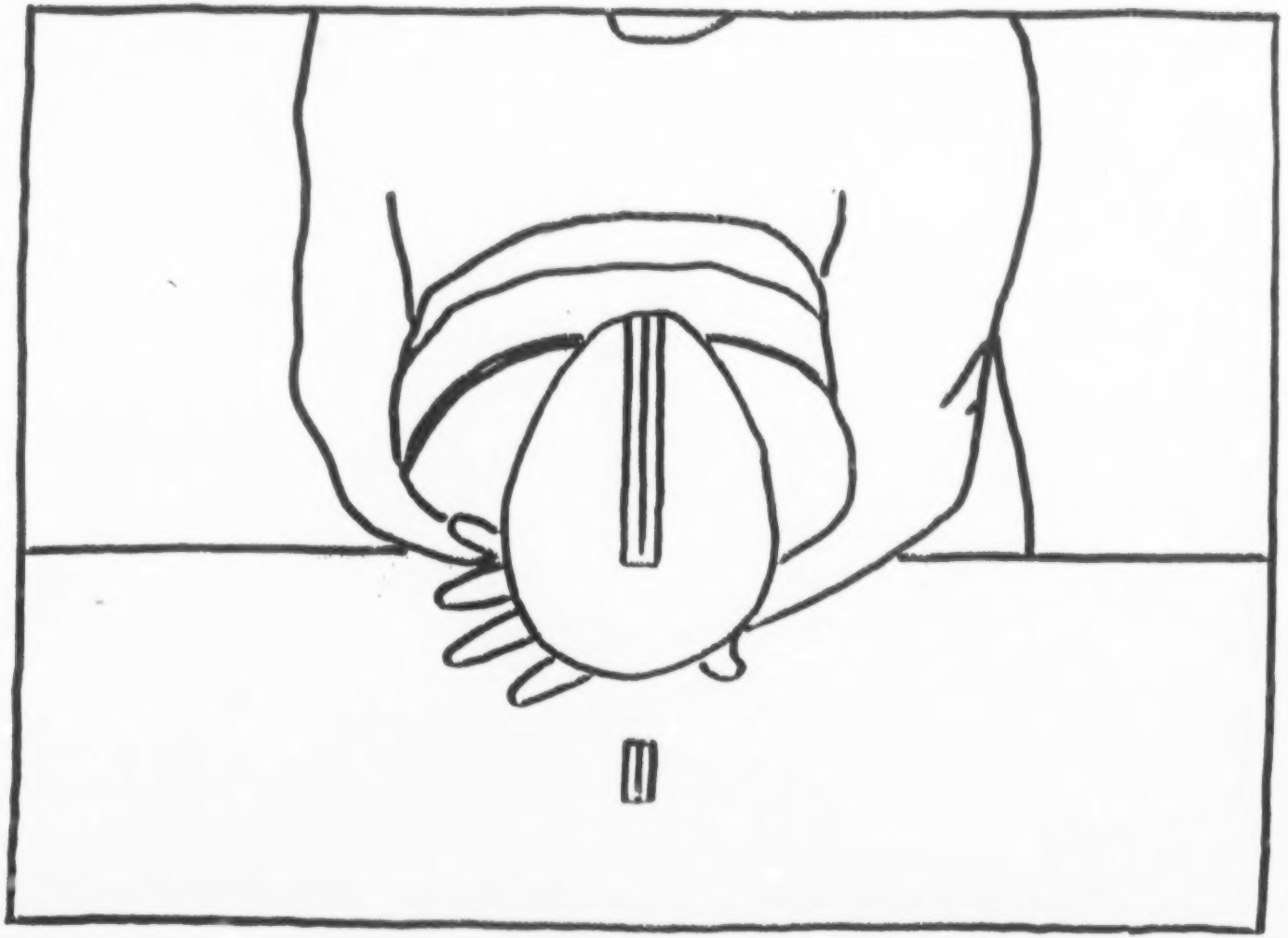
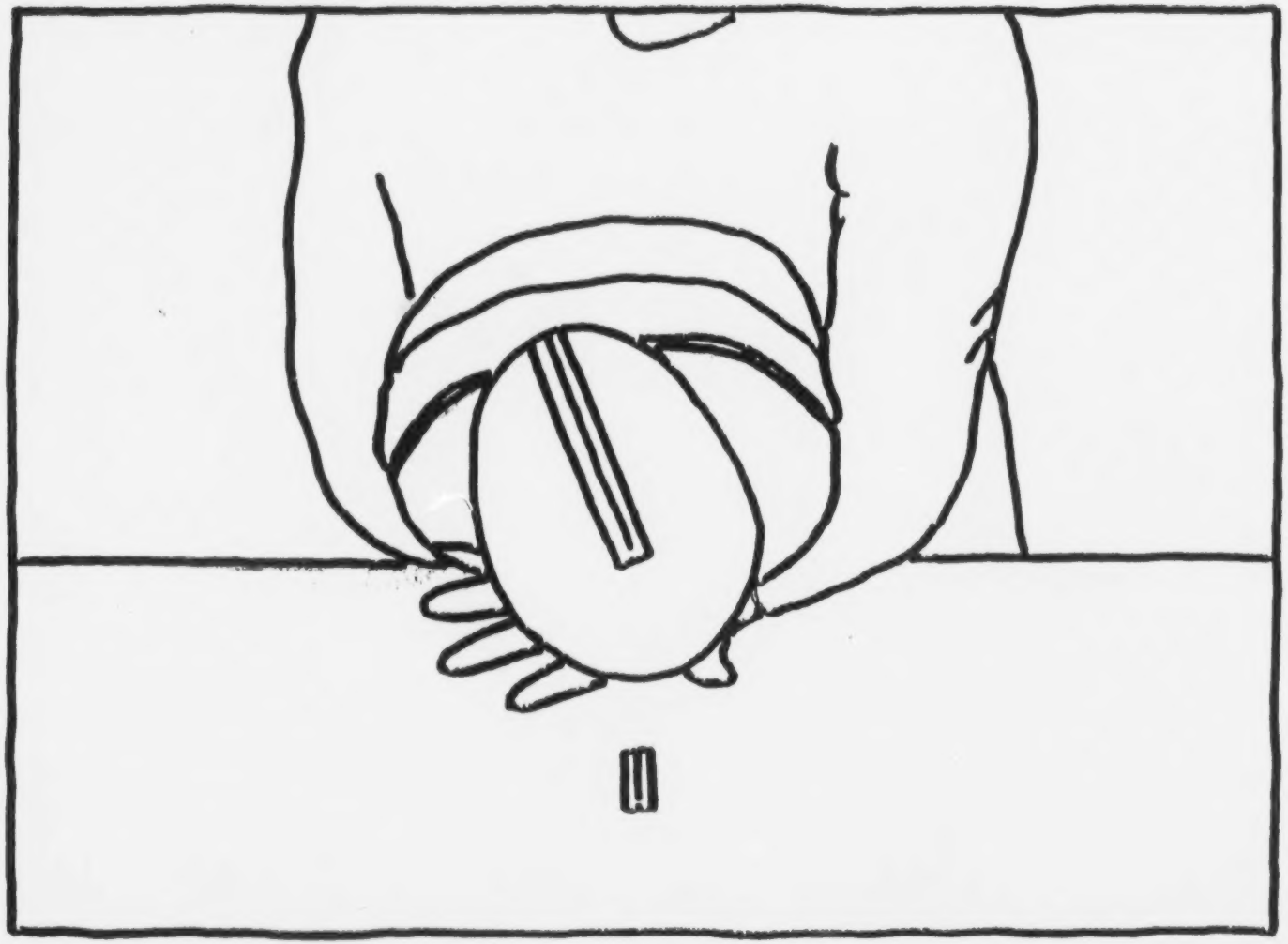




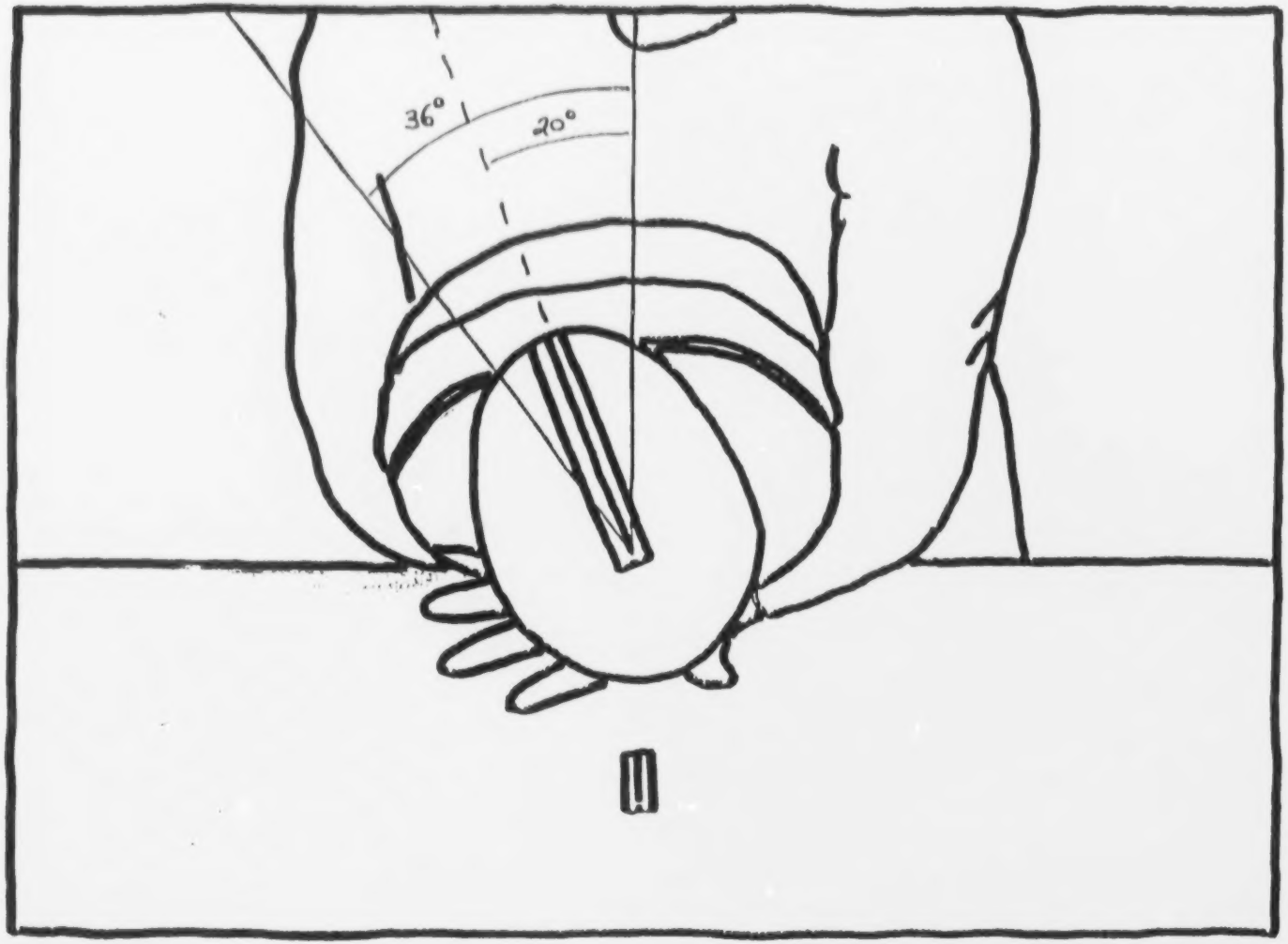
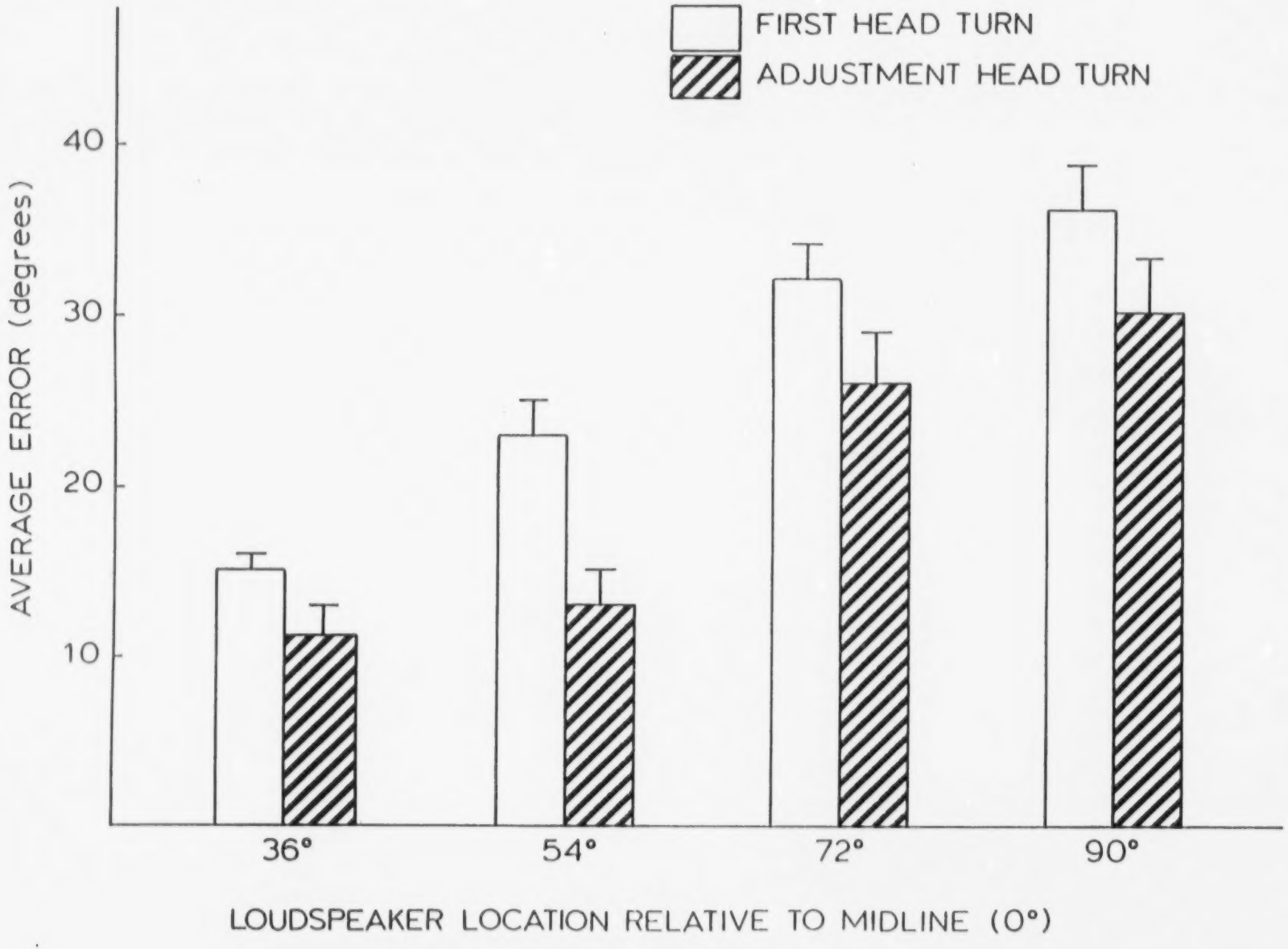

36°
20°

TABLE 1

PROPORTION UNDERSHOOTS VERSUS OVERSHOOTS x ANGLE FOR FIRST HEAD TURNS

	LOUDSPEAKER LOCATION (IN DEGREES)			
RESPONSE TYPE	36	54	72	90
UNDERSHOOTS	.68	.88	.99	1.0
OVERSHOOTS	.32	.12	.01	0


FIRST HEAD TURN
ADJUSTMENT HEAD TURN
AVERAGE ERROR (degrees)
40
30
20
10
36°
54°
72°
90°
LOUDSPEAKER LOCATION RELATIVE TO MIDLINE (0°)